Radiation monitoring and implemented countermeasures in Norway

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Outline

Present monitoring

• Foodstuffs
• Milk and live animals during summer grazing
• Whole body counting

Countermeasures

• CMs implemented annually
• Practicability
• Compensation schemes
• Who pays?

Stakeholder/public perception
Foodstuff monitoring 1

Food basket programme

- Cooperation between NRPA and Norwegian Food Control Authority
- 1 basket purchased per ~40 000 inhabitants / totally ~100 baskets annually
- Comprises goat whey cheese, lamb, beef, reindeer meat, game meat, wild mushrooms and honey
- Samples analysed by local food control stations
- Objectives: to follow long term trends of radioactivity in foodstuffs, act as a control of whether the countermeasures are sufficiently implemented and form a basis for dose estimations for the general public
Table: Results food basket 2002

<table>
<thead>
<tr>
<th>Foodstuff</th>
<th>Median (Bq/kg)</th>
<th>Highest (Bq/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beef</td>
<td>10</td>
<td>50</td>
</tr>
<tr>
<td>Goat whey cheese</td>
<td>74</td>
<td>331</td>
</tr>
<tr>
<td>Game</td>
<td>34</td>
<td>350</td>
</tr>
<tr>
<td>Wild mushrooms</td>
<td>10</td>
<td>416</td>
</tr>
<tr>
<td>Honey</td>
<td>172</td>
<td>470</td>
</tr>
<tr>
<td>Lamb meat</td>
<td>47</td>
<td>590</td>
</tr>
<tr>
<td>Reindeer meat</td>
<td>201</td>
<td>3511</td>
</tr>
</tbody>
</table>

LOD=10 Bq/kg, uncertainty ~10%
Foodstuff monitoring 2

Random sampling of animals in slaughterhouses

- 1% of all carcasses from intervention zones, 0.1% from other zones
- Sampled and analysed by local food control stations
- Any values over 600 Bq/kg (sheep, beef) or 3000 Bq/kg (reindeer) shall immediately be reported to the Norwegian Animal Health Authority
- Objectives: to control whether the countermeasures are sufficiently implemented
## Results random sampling

<table>
<thead>
<tr>
<th>Animal</th>
<th>Number of samples</th>
<th>Geometric mean Bq/kg</th>
<th>Highest value Bq/kg</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sheep</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Free zone</td>
<td>1309</td>
<td>59</td>
<td>1259</td>
</tr>
<tr>
<td>Intervention zone</td>
<td>756</td>
<td>192</td>
<td>5269</td>
</tr>
<tr>
<td><strong>Beef</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Free zone</td>
<td>337</td>
<td>10</td>
<td>512</td>
</tr>
<tr>
<td>Intervention zone</td>
<td>142</td>
<td>17</td>
<td>293</td>
</tr>
<tr>
<td><strong>Reindeer</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Free zone</td>
<td>92</td>
<td>569</td>
<td>2672</td>
</tr>
<tr>
<td>Intervention zone</td>
<td>110</td>
<td>2298</td>
<td>7860</td>
</tr>
</tbody>
</table>
Foodstuffs monitoring 3

Dairy milk

- Analyses performed by the Norwegian food analysis lab
- Dairy samples of cow`s milk and goat`s milk from the most contaminated areas taken once every month in June to September
- Samples taken in all other dairies twice a year (August and October)
- Samples of powdered milk and whey products 3-6 times a year (May to December)
- Approximately 200 samples per year
- Paid by the Norwegian Food Control Authority
Results dairy milk 2003

- Dairy milk: average 2 Bq/L, highest 14 Bq/kg
- Whole milk: average 1 Bq/L, highest 11 Bq/L
- Goat’s milk: average 16 Bq/kg, highest 54 Bq/L

- Food intervention limits: 370 Bq/L for milk, 600 for dairy produce and 50 Bq/L for goat’s milk to be used in production of brown whey cheese

- No dairy products have been discarded since 1996, but as late as in 2002 one dairy refused to accept goat’s milk from a producer due to high concentrations of Cs-137
Milk and live animals during summer grazing

- Monitoring of live sheep from one flock
- Monitoring of cow’s milk from 8 herds
- Monitoring of goat’s milk from 7 herds
Milk and live animals cont`d

• Monitoring starts when animals are let out on pasture (May or June) and continues until they are stalled again in August or September
• Sampling and analyses performed by local food control stations
• High amounts of mushrooms on pastures are quickly reflected in the milk measurements
• Objectives: to give early warning concerning expected levels of radioactivity before the slaughter season in September

(Deposited Cs-137 in 1986: 17 kBq/m²)
## Results Live animals 2003

<table>
<thead>
<tr>
<th>Live animals</th>
<th>ewes</th>
<th>lambs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>19</td>
<td>24</td>
</tr>
<tr>
<td>Lowest, Bq/kg</td>
<td>10</td>
<td>63</td>
</tr>
<tr>
<td>Highest, Bq/kg</td>
<td>784</td>
<td>1260</td>
</tr>
<tr>
<td>Geom. mean, Bq/kg</td>
<td>202</td>
<td>590</td>
</tr>
</tbody>
</table>

Deposition in 1986: 25 kBq/m² of Cs-137
Measurement uncertainty ~20%
Results Milk 2003

Goat`s milk  (deposition in 1986: 104 kBq/m2)  Cow`s milk
Whole body monitoring programme

• Reindeer herders are invited to be measured every three years – 40 people in Northern Norway and 46 people in middle Norway were measured in 2002
• People are measured in a mobile whole body counter for 20 minutes
• Their measurement results are compared to the last measurements performed on spot, and a letter confirming the result sent out later
• Open discussion between herders and experts from NRPA during the whole day (IMPORTANT)
• NRPA pays for travel and a light meal
• Municipality physicians involved
• Programme co-financed by NRPA and the Norwegian Food Control Authority
• Reports produced are sent to the measured people
Results whole body monitoring

Highest single measurement 2002: Man 430 Bq/kg and woman 210 Bq/kg

Norwegian Radiation Protection Authority
Countermeasures in use 2003 (1)

The use of Prussian Blue (AFCF)

• Widely used in concentrates, saltlicks and boli during summer grazing for sheep, goats and cows. Limited use for reindeer, too.
• AFCF is bought as a powder from a German producer
• The Ministry of Agriculture keeps a rolling 2 year stock of AFCF powder
• Concentrates and saltlicks with AFCF are mixed in Norway by the Norwegian agricultural purchasing and marketing Co-Op
• The boli are made by hand at the Norwegian University of Agriculture
• The Ministry of Agriculture pays the additional price for purchase and incorporation of AFCF
• Boli put down by farmer who is compensated for the work
• For reindeer the boli are put down by a veterinarian
Clean feeding combined with live monitoring of sheep

- Used for sheep in autumn
- A selection of all herds (√N) from earlier intervention zones are measured before September 20th by the Norwegian Animal Health Authority
- If the herd's geometric mean is above 700 Bq/kg, the animals must be clean fed before slaughter is allowed
- The biological half-live for sheep is 21 days, so the number of weeks with clean feeding imposed depends on the measured activity concentration
- The farmers are compensated from the second week of clean feeding (0.6 €/animal per day)
- The Ministry of Agriculture pays
Extent of clean feeding 1986-2002

Number of sheep

Norwegian Radiation Protection Authority
Early slaughter combined with live monitoring

- Used for reindeer: slaughter moved forward to Oct/Nov instead of the traditional Dec/Jan slaughter due to seasonal variation in contamination level.
- Compensation for lower slaughter weight paid by the Ministry of Agriculture (6-24 € per calf depending on how early).
- If measurements show that animals >3000 Bq/kg, boli with AFCF or clean feeding can be used with subsequent compensation by the Ministry.
Dietary advice

- General dietary advice is given by the Norwegian Food Control Authority relating consumption frequency and activity concentration.
- Focuses particularly on forest food stuffs like mushrooms, reindeer and game.
- The public can get their food samples measured for free at local food control stations.
- Reindeer herders are advised to make sure that the reindeer meat consumed in the family is below 600 Bq/kg even though the Food Intervention Limit is 3000 Bq/kg.
- The herders are compensated by the Ministry of Agriculture if their reindeer have activity concentrations above 600 Bq/kg (250 € per person in the household and an extra 125 € per person if above 3000 Bq/kg).
- The compensation should be used to clean feed reindeer for household consumption, buy reindeer meat from less contaminated area or buy other meat.
Organisation

Ministry of Agriculture

Food Control Authority
- Sampling, monitoring, dietary advice
- Manufacturers, public
- Advices
- NRPA

Animal Health Authority
- Monitoring, settling of zones, decide length of clean feeding
- Training
- Farmers, herders
- WBC, advices

Reindeer Authority
- Instructions, compensations
- Monitoring, CMs implementation
- Compensations

County and municipality Agricultural departement
- Feedstuff advice, initiate clean feeding, pay compensation
Costs of monitoring, countermeasures and compensation

Total annual sum ~1.8 million €
- 1.25 million € for sheep, goats, cows, foodstuffs
- 0.55 million € for reindeer, herders and WBC

The Ministry of Agriculture pays the costs, some contribution from NRPA for WBC through the Ministry of Health
Stakeholder/public perception today

Media
• Articles locally every year, in national newspapers occasionally
• Descriptive, no exaggerated fear, concern of the long term effect

Consumers
• Rarely questions about radioactivity in foodstuffs from shops (must trust the authorities?)
• Concern in affected areas about radioactivity in self-gathered foodstuffs (mushroom, game, reindeer) – some measure their food before consumption at local food control stations

Farmer/manufacturers
• Have become part of their daily life
• Generally comply with instructions
• Discussions on amount of compensation from time to time
Stakeholder/public perception cont`d

Reindeer herders
- Less content with the situation due to their close spiritual and physical contact with nature and the animals
- Their most important food source is the most contaminated foodstuff in Norway – concern about health and the long term duration of this
- Some choose not to comply with the dietary advice

Monitoring personnel
- Most find the work interesting and important
- Complains about old equipment

Other experts
- Some researchers think the amount of money used for countermeasures is a waste of resources
- Do not believe in the 1 mSv/y recommendation for the public
- Occasionally communicates this to the media etc.
Summary

• The system for monitoring and countermeasure implementation is working satisfactorily
• The contamination levels in some parts of Norway still justifies the use of countermeasures
• The management of radioactivity in the food chain has become part of daily practice
• The long term consequences are much longer than we thought, and we still cannot say when the countermeasures will be redundant – this concern is shared by producers, the public and the authorities